California Regional Water Quality Control Board
North Coast Region
Geoffrey M. Hales, Chairman

Linda S. Adams
Secretary for Environmental Protection

www.waterboards.ca.gov/northcoast
5550 Skylane Boulevard, Suite A, Santa Rosa, California 95403
Phone: (877) 721-9203 (toll free) • Office: (707) 576-2220 • FAX: (707) 523-0135

Arnold Schwarzenegger
Governor

MEMORANDUM

Date: 19 November 2010

To: File: Laguna de Santa Rosa; TMDL Development and Planning

From: Steve Butkus

Subject: Pre-European Settlement Spatial Data Model Evaluation

---

A spatial data model of the Laguna de Santa Rosa (Laguna) watershed representing pre-settlement hydrology and land cover was developed by Regional Water Board staff to help estimate historical pollutant loading. The spatial data model of the pre-settlement map was prepared by assuming model input values based on identified lines of evidence. The pre-settlement spatial data model was designed to delineate the boundaries between six land cover categories:

1. Open Water
2. Perennial wetlands
3. Riverine wetlands
4. Savanna (includes seasonal wetlands)
5. Rangelands
6. Forest Lands

Model evaluation is the process for generating information that helps determine the quality of modeling results to serve as the basis for management decisions (USEPA, 2009). Model evaluation generally follows three main steps. The pre-settlement spatial data model was evaluated according to these steps:

- Sensitivity analysis – evaluates the effect of assumptions on model results.
- Uncertainty analysis - investigates the effects of lack of knowledge and other potential sources of error in the model.
- Model corroboration - evaluates the degree to which the model results correspond to reality.

Pre-Settlement Spatial Model Sensitivity Analysis

A sensitivity analysis evaluates the effect of changes in input values or assumptions on the model results. Two of the assumptions made during development of the pre-settlement spatial data were assessed for model sensitivity:

(1) Areas currently identified as 'Forest' or 'Rangeland' have not changed since European pre-settlement, and
(2) Annual climatic differences in the size of open water areas are represented by comparison of early maps.

The results of these sensitivity evaluations were variations in the total areas of open water, perennial wetlands, rangeland, and forested land covers. The results will be used to assess the effect of these assumptions on the resulting land cover loading model results.

Sensitivity of First Assumption

The first assumption assessed for sensitivity was areas currently identified as 'Forest' or 'Rangeland' in the National Land Cover Database (USGS, 2006) remains generally undisturbed by current landscape management. These areas were assumed to have not changed land cover due to European settlement.

Regional Water Board staff recognize that the 'natural' distribution of vegetation has always been influenced by human activities. The distribution of 'native' vegetation in the Laguna watershed was greatly influenced by indigenous Native Americans. The local Pomo Indians used burning of rangelands to ease the harvest of roots, which suppressed the establishment of woody plants and widened grass rangelands. The native grassland vegetation was reduced significantly after cattle were introduced in the Laguna watershed during the early 1800s after the Spanish colonization. The original Santa Rosa Plain grassland was dominated by a mix of perennial bunchgrasses and annual forbs. The cattle destroyed the forage base of native grasses which were not adapted to such heavy use. The native grasses were replaced with new vegetation from the Mediterranean that could survive livestock grazing.

Staff applied a gradient analysis to estimate how different the forest and rangeland covers would be if based solely on soils, slope, and elevation, and assessed the spatial model sensitivity of the first assumption on land cover changes due to human landscape management. Application of the gradient analysis to predict vegetation type based on soils, slope, and elevation infers a landscape without human influence. Without human management of the landscape, the vegetation could delineate into spatial patterns driven by influencing environmental factors. The gradient analysis of the Laguna watershed found soils (soil hydrogroup and soil percent silt), slope and elevation could determine the spatial distribution of vegetation that could occur naturally without human influence (Butkus, 2010).

By using the results of the gradient analysis, the areas that were assumed to be 'Forest' or 'Rangeland' based on current land cover were assessed for potential vegetation type based on soil characteristics and topology. These areas were used in a non-hierarchical K-means cluster analysis to forest areas from rangelands based on the four most significant environmental variables. The clustering was used to delineate all areas of 'Forest' or 'Rangeland' using environmental gradients for the sensitivity analysis.

The results of the sensitivity analysis on the first assumption show pre-settlement rangelands would cover a larger area than predicted from current landscape maps (Table 1). The 'Rangeland' areas could have been 75% larger and the 'Forest' areas 22% smaller than predicted by assuming forest and rangelands have not changed since European pre-settlement.

Table 1. Difference in Land Cover Areas by Analysis Assumptions

Land Cover Category	Cluster Analysis (acres)	Gradient Analysis (acres)	Change (%)
Rangelands	24,292	42,564	75%
Forest Lands	84,515	66,290	-22%

Sensitivity of Second Assumption

The second assumption assessed for sensitivity was that annual climatic differences in the size of open water areas were represented by comparison of early maps.

Regional Water Board staff recognize the open water boundaries from year-to-year likely varied considerably prior to European settlement and after settlement as hydraulic modifications were made in the watershed. The boundaries between open water and marshlands were very dynamic depending on the season and annual climate.

The historical open water boundary during dry years was derived from the boundary of open water depicted on the 1860 Laguna map (E-131 Llano de Santa Rosa - Courtesy of The Bancroft Library, University of California, Berkeley) The 1860 map presented the smallest open water area of all the available early maps. The historical boundaries of the open water areas during wet years were based on two historical maps (Bowers, 1867; Thompson, 1877), soil type, and landform. The area between the boundaries of the open water for wet and dry years was assumed to represent perennial marshes during the dry years.

The differences between the areas of open water and perennial marsh based on the second assumption are shown in Table 2. The assumption results in a large relative change in open water areas during wet years, with relatively little loss in perennial wetland areas

Table 2. Difference in Land cover areas between wet and dry annual climatic years

Land Cover Category	Dry Years	Wet Years	Change

	(acres)	(acres)	(%)
Open Water	79	3,045	3,754%
Perennial wetlands	19,935	16,969	-16%

Pre-Settlement Spatial Model Uncertainty Analysis

Regional Water Board staff quantified the level of certainty of the pre-settlement spatial data model through the uncertainty analysis which investigates the effects of lack of knowledge and other potential sources of error in the model. The level of certainty in the reconstructed historical maps can be affected by many factors, including: accuracy of the source maps, condition of the maps, goals of the original data collection, timing of the original mapping, and contemporary interpretation.

The uncertainty of mapped features in the Laguna pre-settlement spatial data was rated based on the number and quality of information sources. For example, a spatial feature would receive a high certainty rating (i.e., more certain that the feature existed) if the information was based on soils characteristics, landform characteristics, and was supported by other cartographic data sources.

The resulting rating scores are shown in Table 3 and were area weighted for an overall uncertainty rating score of 1.7. This rating suggests that the pre-settlement spatial data is somewhere between a 'Probable' and 'Possible' level of uncertainty. This approach follows a commonly applied qualitative approach to assessing uncertainty in historical map reconstructions (Grossinger, 2001). The qualitative assessments were standardized (Schuster and Zuuring ,1986) and scored by the trisection approach (USEPA, 1998).

Table 3. Uncertainty Ratings of Mapped Features

Level of Certainty	Certainty Rating	Land Cover Category	Information Sources	Area (acres)
Definite	5	Open Water	1860 Map 1867 Map 1877 Atlas Maps Soil Characteristics Landform	3,045
		Riverine Wetlands	1990 Riparian Maps Soil Characteristics Landform	2,831
Probable	3	Perennial Wetlands	Soil Characteristics Landform	16,969
		Riverine Wetlands	Soil Characteristics Landform	2,314
		Savanna	Soil Characteristics	28,823

			Landform	
Possible	1	Rangeland	2006 Land Cover Map Gradient Analysis	24,292
		Forest Lands	2006 Land Cover Map Gradient Analysis	84,515

Pre-Settlement Spatial Model Corroboration

Model corroboration is the process of evaluating the degree to which the model corresponds to reality. Model corroboration is often incorrectly referred to as model validation or verification (USEPA, 2009). Quantitative model corroboration often uses statistics to estimate how closely the model results match measurements made in the real system. Qualitative corroboration activities may include expert elicitation for data-poor situations.

Regional Water Board staff corroborated the pre-settlement land cover spatial data model by evaluating data from the General Land Office (GLO) surveys. The surveys were conducted during the mid 19th century and they provide a key data source of forest and environmental conditions of the pre-European settlement period (Bourdo, 1956). At section corners, nearby witness trees were identified with the distance and bearing. The surveyors also often documented other land features, vegetation, wetlands and open water. GLO survey information provides the only reasonably accurate data source of forest composition and tree species distribution during the late pre-European settlement period despite the survey biases including surveyor's preference and exclusion of certain species and age groups (Manies and Mladenoff, 2000; Manies et al., 2001).

Regional Water Board staff manually entered the recorded surveyor information into a spatial database for model corroboration. The available GLO survey information was limited due to the coarse sampling structure. Full surveys were not available in some land grant 'ranchos' that were platted prior to the GLO surveys. Information was recorded at only eighty-nine (89) survey points within the Laguna watershed (Figure 1).

Information compiled included the bearing and distance to witness trees, species observed, and surveyor notes. Tree density was estimated from recorded distances to witness trees (Morisita, 1957). The percentage of each land cover type was determined for the area within 0.1 mile of each survey location (~20 acres) from the pre-settlement land cover spatial data model.

The pre-settlement land cover percentages were compared to the compiled information from the GLO surveys. Each survey point was rated on how well the GLO survey information supports the pre-settlement land cover estimates. Survey locations were rated whether the information "Fully", "Partially" or "Did Not" corroborate the predicted land cover from the pre-settlement land cover spatial data model (Table 1).

Overall, the pre-settlement spatial data model corroborated well with the information recorded in the GLO surveys. The results of the comparison showed that for seventy-one percent (71%) of the survey locations, the land cover data model was in full agreement with the GLO survey information. Nineteen percent (19%) of the survey locations showed some agreement and ten percent (10%) showed no agreement the between the GLO survey records and the pre-settlement land cover.

CITATIONS

Bowers, A.B. 1867. Map of Sonoma County, California. Map is found as an Appendix to David W. Smith Consulting, 1990.

Buordo, E. A. 1956 A review of the General Land Office Survey and of its use in quantitative studies of former forests. Ecology, 37, 754-768.

Butkus, S. 2010. Gradient Analysis of Environmental Variables to Delineate Pre-European Settlement Land Cover Boundaries. Memorandum to the Laguna TMDL File dated November 19, 2010. North Coast Regional Water Quality Control Board, Santa Rosa, CA.

Gossinger, R. 2001. Documenting Local Landscape Change. In *The Historical Ecology Handbook: A Restorationist's Guide to Reference Ecosystems.* edited by D. Egan and E.A. Howell, Island Press, Washington, DC.

Manies, K. L., Mladenoff, D. J. (2000) Testing methods to produce landscape-scale presentment vegetation maps from the U. S. public land survey records. Landscape Ecology, 15, 741-754.

Manies, K. L., Mladenoff, d. J., Nordheim, E. V. (2001) Surveyor bias in forest data of the U. S. General Land Office records for northern Wisconsin. Canadian Journal of Forest Research 31: 1719-1730.

Morisita, M. 1957. A new method for the estimation of density by the spacing method, applicable to non-randomly distributed populations. Physiology and Ecology - Kyoto **7:**134–144.

Schuster, E.G. and H.R. Zuuring. 1986. Quantifying the unquantifiable: Or have you stopped abusing measurement scale? *Journal of Forestry* 1986:25-30.

Thompson, T.H. 1877. Historical Atlas of Sonoma County. T.H. Thompson and Co., Oakland, CA.

USEPA, 1998. Lake and Reservoir Bioassessment and Biocriteria Technical Guidance Document. Publication No. 841B98007. U.S. Environmental Protection Agency, Washington, DC.

USEPA, 2009. Guidance on the Development, Evaluation, and Application of Environmental Models. Publ. No. EPA/100/K-09/003. Council for Regulatory Environmental Modeling, U.S. Environmental Protection Agency, Washington, DC.

USGS, 2006. Enhanced Historical Land-Use and Land-Cover Data Sets of the U.S. Geological Survey. Data Series 240. U.S. Geological Survey. http://pubs.usgs.gov/ds/2006/240/.

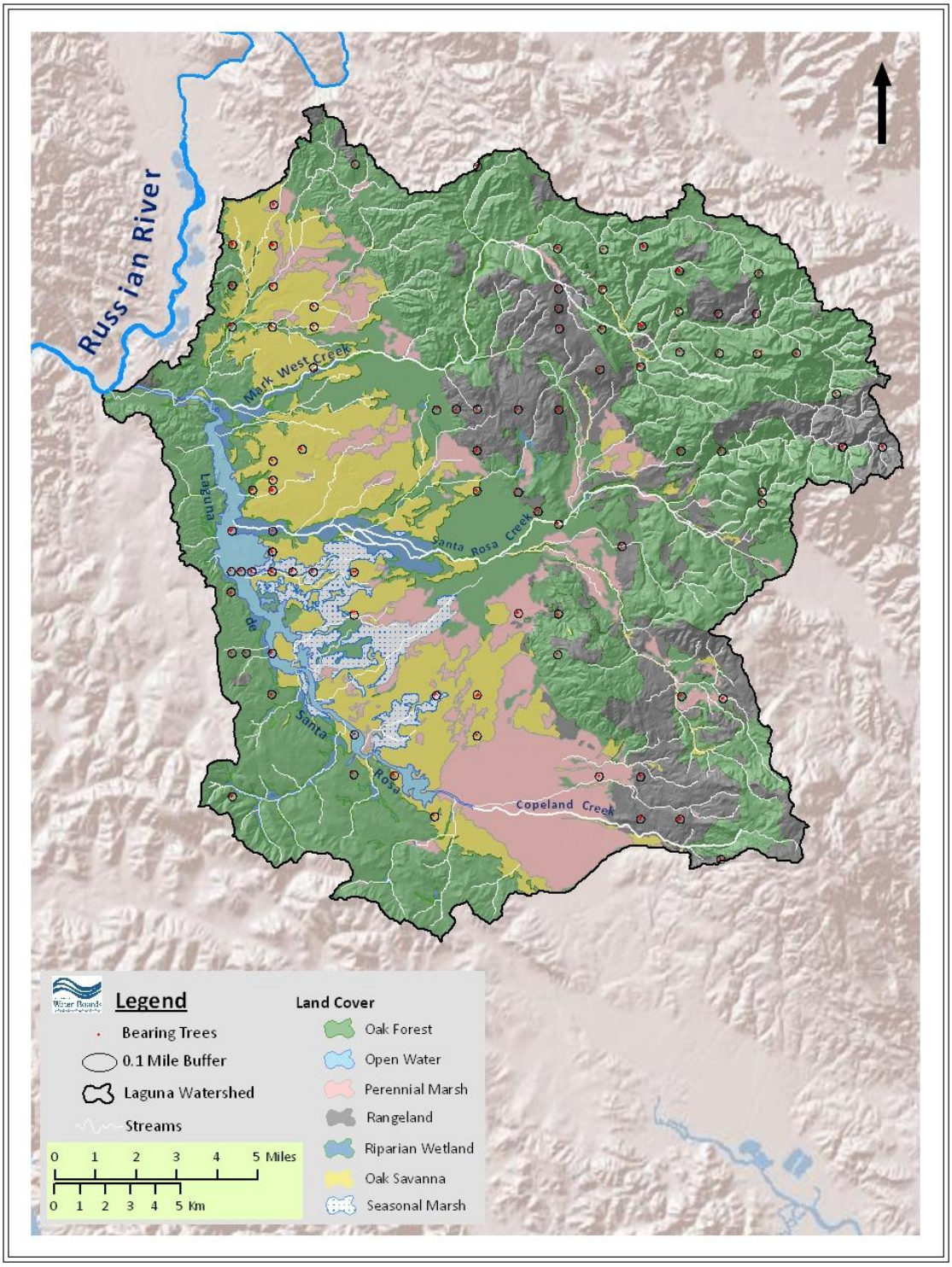

Figure 1. GLO Recorded Survey Locations in the Laguna Watershed

Table 1. Comparison of the GLO Survey Records with Estimated Pre-Settlement Land Cover.

Survey point	Tree Species Observed	Tree Density (trees /acre)	Surveyor Notes	Forest (%)	Rangeland (%)	Oak Savanna (%)	Riparian Wetland (%)	Perennial Marsh (%)	Seasonal Wetland (%)	Open Water (%)	Spatial Data Model Support
1	Live oak	12.7	Land very hilly and rocky in some places and very little timber	100%	0%	0%	0%	0%	0%	0%	Full
2	White oak	2.6	Land level. Soil 1st rate. Timber scattering white oaks.	98%	0%	0%	0%	2%	0%	0%	Full
3	White oak	0.5	Land level. Soil 2nd rate. Timber white oak.	43%	7%	0%	0%	50%	0%	0%	Partial
4	White oak	-	Land level. Soil 3rd rate. No timber.	0%	0%	0%	0%	100%	0%	0%	Partial
5	White oak	1.2	Land 1st rate. Timber, scattering white oak.	0%	100%	0%	0%	0%	0%	0%	Full
6	Black oak, White oak	1.2	Land rolling and sparsely wooded with black & white oaks. Soil 2nd rate.	0%	100%	0%	0%	0%	0%	0%	Full
7	Black oak, White oak	0.6	Land rolling. Soil 2nd rate. Timber scattering oaks.	0%	100%	0%	0%	0%	0%	0%	Full
8	No timber	-	Land very rough and covered with hard burned granite rock.	24%	76%	0%	0%	0%	0%	0%	Full
9	White oak	2.7	Land level. Soil 1st rate. Timber scattering white oaks.	0%	0%	5%	0%	0%	95%	0%	Not
10	White oak	0.5	Land level. Soil 2nd rate. Timber white oak.	0%	0%	100%	0%	0%	0%	0%	Full
11	None reported	-	Land level. Soil 2nd rate.	0%	0%	100%	0%	0%	0%	0%	Full
12	White oak	3.0	Land level, soil 1st rate, timber principally white oak.	0%	0%	14%	0%	0%	0%	86%	Partial

Survey point	Tree Species Observed	Tree Density (trees /acre)	Surveyor Notes	Forest (%)	Rangeland (%)	Oak Savanna (%)	Riparian Wetland (%)	Perennial Marsh (%)	Seasonal Wetland (%)	Open Water (%)	Spatial Data Model Support
13	White oak	-	Land level. Soil 3rd rate. No timber.	100%	0%	0%	0%	0%	0%	0%	Full
14	White oak	0.3	Land level. 2nd rate and subject to overflow from Lagoon in wet season. Top of grassy spur with scattering oaks.	56%	0%	44%	0%	0%	0%	0%	Full
15	Black oak	-	Land rolling and sparsely wooded with black and white oaks. Soil 2nd rate.	15%	0%	85%	0%	0%	0%	0%	Full
16	White oak	9.3		1%	0%	0%	16%	0%	0%	82%	Not
17	Madrone, Red oak	5.6		100%	0%	0%	0%	0%	0%	0%	Full
18	Black oak, Madrone	3.3		100%	0%	0%	0%	0%	0%	0%	Full
19	Black oak, White oak	2.2	Surface gently rolling. Soil 2nd rate. Black and White oak timber.	97%	0%	0%	3%	0%	0%	0%	Full
20	Black oak	8.5		99%	0%	0%	1%	0%	0%	0%	Full
21	None reported	-	Land broken, third rate, covered with chamisal.	95%	5%	0%	0%	0%	0%	0%	Not
22	None reported	-	Line runs on north slope of a long ridge, land third rate. Timber oak, fir, laurel, madrone, and maple. Undergrowth same - buckeye, Manzanita, dogwood, nutmeg, and chamisal.	18%	82%	0%	0%	0%	0%	0%	Full
23	Live oak, Laurel	55.4		16%	84%	0%	0%	0%	0%	0%	Full

Survey point	Tree Species Observed	Tree Density (trees /acre)	Surveyor Notes	Forest (%)	Rangeland (%)	Oak Savanna (%)	Riparian Wetland (%)	Perennial Marsh (%)	Seasonal Wetland (%)	Open Water (%)	Spatial Data Model Support
24	Oak	3.1	Land broken, third rate. First half mile covered with chamisal, north half timbered - oak, fir and madrone. Undergrowth same with buckeye & Manzanita.	0%	100%	0%	0%	0%	0%	0%	Full
25	Live oak	17.2	Rocky hill side, third rate soil	0%	100%	0%	0%	0%	0%	0%	Partial
26	Black oak	21.1	Land broken. Soil 3rd rate. Timber oak, madrone, fir. Undergrowth chaparral.	100%	0%	0%	0%	0%	0%	0%	Full
27	None reported	-	Land broken. Soil 3rd rate. Scattering timber of oak, madrone, fir, and redwood. Undergrowth chaparral and Manzanita.	100%	0%	0%	0%	0%	0%	0%	Full
28	None reported	-	Land very broken, soil 3rd rate. No timber. Dense undergrowth of Manzanita and chaparral. The land to the south and west being covered with chaparral, with soil unfit for cultivation.	100%	0%	0%	0%	0%	0%	0%	Full
29	Madrone	-	Land third rate, hilly, and covered with dense growth chaparral.	100%	0%	0%	0%	0%	0%	0%	Partial
30	Willow, Alder	2.1		75%	0%	0%	25%	0%	0%	0%	Full
31	Oak	81.6		0%	100%	0%	0%	0%	0%	0%	Not
32	Red oak, White oak	0.6	On the first mile open valley, soil first quality. On last half mile hilly, soil	88%	12%	0%	0%	0%	0%	0%	

Survey point	Tree Species Observed	Tree Density (trees /acre)	Surveyor Notes	Forest (%)	Rangeland (%)	Oak Savanna (%)	Riparian Wetland (%)	Perennial Marsh (%)	Seasonal Wetland (%)	Open Water (%)	Spatial Data Model Support
			second quality								Full
33	LIve oak	-	NO other tree at hand. ground too rocky for pits. Chaparral ridges. Soil valueless.	0%	100%	0%	0%	0%	0%	0%	Full
34	Black oak	-	Land high undulating grassy foot hills covered with clumps of oats. Red soil second rate. Good grazing.	0%	100%	0%	0%	0%	0%	0%	Full
35	None reported	-	Level valley. Timber large black oak, white oak, frce from underbrush. Grazing excellent.	100%	0%	0%	0%	0%	0%	0%	Full
36	White oak	0.7	Some good grazing land but for the greater portion very broken and rocky.	6%	94%	0%	0%	0%	0%	0%	Full
37	Red oak	0.4		4%	96%	0%	0%	0%	0%	0%	Full
38	White oak	-		12%	88%	0%	0%	0%	0%	0%	Partial
39	White oak	0.9		57%	43%	0%	0%	0%	0%	0%	Full
40	White oak	8.2		30%	0%	70%	0%	0%	0%	0%	Partial
41	White oak	0.4		0%	0%	94%	0%	0%	6%	0%	Full
42	White oak	1.7		0%	0%	28%	0%	0%	72%	0%	Partial
43	Red oak	2.2		9%	0%	51%	0%	40%	0%	0%	Full
44	White oak	5.5		0%	0%	0%	0%	100%	0%	0%	Not
45	White oak, Black oak	9.3	Land gently rolling. Timber scattering white and black oak. soil 2nd rate.	0%	0%	100%	0%	0%	0%	0%	Partial
46	Black oak	15.4		0%	0%	100%	0%	0%	0%	0%	Not

Survey point	Tree Species Observed	Tree Density (trees /acre)	Surveyor Notes	Forest (%)	Rangeland (%)	Oak Savanna (%)	Riparian Wetland (%)	Perennial Marsh (%)	Seasonal Wetland (%)	Open Water (%)	Spatial Data Model Support
47	White oak	0.6	Land level. Not trees near. Soil 2nd rate.	0%	0%	100%	0%	0%	0%	0%	Full
48	White oak	0.7	Land gently rolling. Timber scattering white and black oak. soil 2nd rate.	0%	0%	100%	0%	0%	0%	0%	Full
49	Black oak	6.1	Land rolling. Timber scattering. Black and white oak. Soil 2nd rate.	7%	0%	61%	32%	0%	0%	0%	Partial
50	White oak	0.9	No other trees near. The first 1/2 mile of this line in water of the Lagoon, the remainder gently rolling. Timber scattering - white, black oak & willow. The Lagoon covers some land at this time that has been in cultivation.	0%	0%	0%	0%	0%	0%	100%	Full
51	Granite rock	-	No trees near for bearings. Land gently rolling. Timber scattering white & black oak, soil 2nd rate.	0%	0%	0%	100%	0%	0%	0%	Partial
52	White oak	1.7		0%	0%	83%	0%	0%	17%	0%	Full
53	White oak	1.1	Land gently rolling.	0%	0%	44%	0%	0%	7%	49%	Partial
54	White oak, Black oak	3.0		0%	0%	11%	0%	0%	89%	0%	Partial

Survey point	Tree Species Observed	Tree Density (trees /acre)	Surveyor Notes	Forest (%)	Rangeland (%)	Oak Savanna (%)	Riparian Wetland (%)	Perennial Marsh (%)	Seasonal Wetland (%)	Open Water (%)	Spatial Data Model Support
55	Ash, Lagoon Water	-	Lagoon at this time about 12 in deep. The most of this mile on dry ground remainder in the water of the Lagoon from 2 to 12 inches deep. The soil 2nd rate with scatterry white oak timber. The greater part that is covered with water at this time, is dry at other seasons. Mostly covered w/ a growth of willow & ash timber, with tule. No trees near of any size for bearings.	0%	0%	0%	0%	0%	0%	100%	Full
56	White oak, Black oak, Madrone	2.1		100%	0%	0%	0%	0%	0%	0%	Full
57	Lagoon water	-	Lagoon water shallow. Deeper water I here set post. Channel about 3 feet deep.	0%	0%	0%	0%	0%	0%	100%	Full
58	Red oak, White oak	0.6		100%	0%	0%	0%	0%	0%	0%	Full
59	Black oak, Live oak	2.2	Land steep. Soil 3rd rate. Timber scattering oak. Undergrowth chamizal.	100%	0%	0%	0%	0%	0%	0%	Full
60	None reported	-	Land steep. Soil 3rd rate. Timber scattering oak. Undergrowth chamizal.	100%	0%	0%	0%	0%	0%	0%	Full

Survey point	Tree Species Observed	Tree Density (trees /acre)	Surveyor Notes	Forest (%)	Rangeland (%)	Oak Savanna (%)	Riparian Wetland (%)	Perennial Marsh (%)	Seasonal Wetland (%)	Open Water (%)	Spatial Data Model Support
61	White oak, Live oak	1.7	On Sec. 13 quite an extensive coal bed has been discovered, though of inferior quality. No value for cultivation, a little grazing land on the NE 1/4. Scattering black & white oak.	100%	0%	0%	0%	0%	0%	0%	Full
62	Black oak, White oak	16.8	This line lays along the North side and near the summit of mountain covered with rock and chaparral. Sec. 24 is part of an immense chaparral mountain.	0%	100%	0%	0%	0%	0%	0%	Full
63	None reported	-	No trees, the bedrocks are coming to the surface so that I could not dig pits.	0%	100%	0%	0%	0%	0%	0%	Full
64	Willow, Ash	18.8	On the bank of Mark West Creek. Land steep. Soil 3rd rate. Timber scattering oak. Undergrowth chamizal.	59%	0%	41%	0%	0%	0%	0%	Full
65	Live oak, Black oak	0.9	Land steep. Soil 3rd rate. Timber scattering oak. Undergrowth chamizal.	100%	0%	0%	0%	0%	0%	0%	Full
66	Black oak	14.3	Land steep, soil 3rd rate. Timber scattering	100%	0%	0%	0%	0%	0%	0%	Full
67	White oak, Fir	23.7	Land steep and broken. Soil 3rd rate. Timber scattering - oak and fir.	6%	94%	0%	0%	0%	0%	0%	Partial
68	None reported	-	Land generally steep. Soil 3rd rate. Timber scattering oak and pine.	0%	100%	0%	0%	0%	0%	0%	

Survey point	Tree Species Observed	Tree Density (trees /acre)	Surveyor Notes	Forest (%)	Rangeland (%)	Oak Savanna (%)	Riparian Wetland (%)	Perennial Marsh (%)	Seasonal Wetland (%)	Open Water (%)	Spatial Data Model Support
			Undergrowth chamizal.								Partial
69	None reported	-	Land steep, soil 3rd rate. Timber scattering oak and fir. Undergrowth chamizal.	100%	0%	0%	0%	0%	0%	0%	Full
70	Live oak, Black oak	1.1	Land generally steep. Soil 2nd & 3rd rate. Timber scattering oak. Undergrowth chamizal.	100%	0%	0%	0%	0%	0%	0%	Full
71	Live oak, Black oak, Pepperwood	1.8	Land steep. Soil 3rd rate. Timber scattering oak. Undergrowth chamizal	100%	0%	0%	0%	0%	0%	0%	Full
72	Live oak	-	Land mountainous and valueless.	0%	100%	0%	0%	0%	0%	0%	Full
73	None reported	-	Land steep. Soil 2nd rate. Timber scattering oak.	0%	100%	0%	0%	0%	0%	0%	Partial
74	White oak, Black oak	2.1	Land steep, Soil 3rd rate. Timber scattering oak.	100%	0%	0%	0%	0%	0%	0%	Full
75	None reported	-	Land steep, soil 3rd rate. Timber scattering oak, fir, madrone. Undergrowth chamizal.	100%	0%	0%	0%	0%	0%	0%	Full
76	None reported	-	Land steep. Soil 3rd rate. Timber scattering oak and fir. Undergrowth chamizal.	100%	0%	0%	0%	0%	0%	0%	Full
77	White oak	0.1	Land steep and broken. Soil 3rd rate. Timber scattering oak and fir. Undergrowth chamizal.	100%	0%	0%	0%	0%	0%	0%	Full

Survey point	Tree Species Observed	Tree Density (trees /acre)	Surveyor Notes	Forest (%)	Rangeland (%)	Oak Savanna (%)	Riparian Wetland (%)	Perennial Marsh (%)	Seasonal Wetland (%)	Open Water (%)	Spatial Data Model Support
78	None reported	-	Sec 2 is entirely valueless nothing but chaparral, mountains. Very rough and rocky.	100%	0%	0%	0%	0%	0%	0%	Not
79	Black oak, Live oak	0.7	No other trees. High hill sparsely covered with timber, chiefly black oak. Some grazing land.	98%	2%	0%	0%	0%	0%	0%	Full
80	None reported	-	Set 1/4 sec corner post in mound of rocks in chapparel. No trees, the bed rocks coming to the surface so that I could not dig pits.	0%	0%	100%	0%	0%	0%	0%	Full
81	Live oak	-	Land mountainous and valueless.	0%	0%	100%	0%	0%	0%	0%	Not
82	White oak	-	Mound trenches and so forth, soil second quality, land a little rolling.	0%	0%	43%	57%	0%	0%	0%	Full
83	Red oak	5.6	Land gently rolling. Soil 3rd rate. Timber white and red oak.	0%	0%	32%	0%	68%	0%	0%	Not
84	White oak, Red oak	0.8	Land gently rolling 3rd rate. Scattering white and red oak. Timber no underbrush.	0%	0%	100%	0%	0%	0%	0%	Full
85	Red oak, White oak, Madrone	1.4	Land hilly, soil 3rd rate. Timber white and red oak.	34%	0%	66%	0%	0%	0%	0%	Full
86	Red oak, White oak, Madrone	7.7	First half mile level 2nd rate the balance rolling 3rd rate. Scattering timber white and red oak.	100%	0%	0%	0%	0%	0%	0%	Full

Survey point	Tree Species Observed	Tree Density (trees /acre)	Surveyor Notes	Forest (%)	Rangeland (%)	Oak Savanna (%)	Riparian Wetland (%)	Perennial Marsh (%)	Seasonal Wetland (%)	Open Water (%)	Spatial Data Model Support
87	White oak	0.8	No other trees near in the other section. Land gently rolling, bottom dry 2nd rate, the other 3rd rate.	27%	0%	69%	0%	5%	0%	0%	Full
88	None reported	-	The land rolling 2nd rate. Creek bottom dry. 1st rate, very little timber	43%	0%	38%	4%	15%	0%	0%	Partial
89	White oak	0.7	No trees near. Land half mile rolling 2nd rate. Last half mile bottom dry, 1st rate. A few scattering trees. White and red oak.	84%	0%	0%	16%	0%	0%	0%	Partial